Appendix L
Water Conservation Case Studies

DRAFT TECHNICAL MEMORANDUM

SUBJECT: **Brazos G RWPG Water Conservation Case Studies**

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DATE: **April 9, 2004 (revised September 2, 2004)**

INTRODUCTION

Water conservation is an important component to water planning. As demands on water resources increase, the ability to reduce water consumption through conservation will become more necessary. In the Brazos G region alone, water demands are projected to increase 110 billion gallons per year (368,600 acre-feet per year) over the planning horizon (2000 to 2060). Approximately 80 percent of this increase is associated with municipal and manufacturing demands.

Previous planning included water conservation in the planning process through assumed reductions in municipal per capita use. The amount of reduction was based on two components: 1) reductions associated with the conversion of high flow plumbing fixtures to low flow fixtures as required by the Texas Plumbing Efficiency Standards (Energy Policy Act of 1992), and 2) reductions due to an "expected level" of additional water conservation. Additional conservation beyond the expected level was evaluated in the 2001 plan to meet municipal and manufacturing water needs, and was a recommended strategy for two cities, Baird and Stamford. The savings due to advanced conservation were estimated at 5 percent of the projected demands at a cost of $574 per acre-foot of water saved.

The second round of water planning modified the approach to water conservation to more clearly document water savings associated with conservation strategies and emphasize the importance of conservation in long-range planning. Municipal demands for this planning cycle include only reductions associated with the adoption of plumbing code requirements. Additional conservation is to be evaluated as a water management strategy. The planning guidelines state that water conservation must be considered for every identified water need. If the RWPG does not recommend a water conservation strategy for a need, it must document the reason (30 TAC §357.7(a)(7)(A)).

Each region is to develop model water conservation plans with management recommendations appropriate for the region. These plans will need to comply with recent legislation that requires 5- and 10-year specific, quantifiable targets for water savings to be included in the water conservation or management plans. In addition, the Texas Legislature authorized the formation of a Water Conservation Implementation Task Force to identify Best Management Practices for water conservation, assist with standardizing reporting data, review recommended conservations strategies in regional water plans and assess the role for state funding. The work of this task force is on-going and will be considered during this round of water planning. Some of the preliminary recommendations being considered by the Task Force include a target total water use of 140 gallons per capita per day for municipal water users and annual 1 percent reductions in per capita water to meet target goals. A final report to the Texas Legislature of the Task Force's recommendations is due by November 1, 2004.

As evidenced by the emphasis placed on water conservation by the Legislature and regional water planning efforts, there has been much discussion on the benefits and quantities of water savings associated with conservation measures. A recent study commissioned by the Texas Water Development Board (TWDB)[1] quantified water savings associated with different efficiency strategies. Representatives of local municipalities debated the realization of these savings in an operating retail distribution system. In response to these concerns, water conservation case studies for two communities were performed, one with an aggressive conservation program and one with a more passive program. The purpose of these studies was to provide supporting data in which to evaluate potential conservation strategies to meet identified needs in the Brazos G region. As part of this task, data were collected on water use, population, economic activity, weather, funding commitments, and other pertinent information necessary to assess the effectiveness of existing water conservation programs. The findings of this study will be part of the evaluations of water management strategies for the Brazos G region.

Two communities were selected for the water conservation case studies: Temple and Austin. The original scope of work proposed that the conservation studies compare two cities located in Williamson or Bell County. However, in an effort to include a city with a more proactive water conservation program, Austin was selected as the second city. While not located in the same planning region (Austin is located in Region K), Temple and Austin have similar geographic locales and climates.

In order to conduct the case study, the water conservation efforts of each community were documented and compared. The effectiveness of each water conservation program was determined based on water use changes after implementation of the program.

MEASUREMENTS AND DEFINITIONS

Gallons per Capita per Day (GPCD)

Water use can be reported in many different ways. The most common method of reporting municipal water use is through an assessment of per capita water use. While this measurement appears to be straightforward, the calculations and meanings of these values are widely debated. The TWDB has historically calculated per capita water use as:

(Total water pumped – wholesale water sales – industrial sales) / population / 365 days

The Conservation Implementation Task Force recently adopted several definitions of per capita water use, one being "total gallons per capita per day" (gpcd) and another being "residential gpcd". The total gpcd is similar to the TWDB's definition of gpcd, but does not subtract the industrial sales. The residential gpcd is calculated using only single family and multi-family metered sales. The residential gpcd requires separate tracking of water sales. For many entities, these data are only available for recent years. Most cities have data documenting total water pumped and wholesale sales. Industrial use may be tracked separately or estimated as a percentage of the total use.

[1] GDS Associates. *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas*, May 2003.

Since historical data are available from the TWDB (1980 to 2003), and the focus of this study is on municipal conservation efforts, this study uses the TWDB definition of gpcd for long-term municipal comparison purposes. Monthly water usage data were available only for the total amount pumped. Analyses of monthly data were performed using the total water use.

Population
Another issue of debate is the definition of "population." The TWDB reports population for a city based on estimates from the State Data Center, but the TWDB does not report service area populations. Service area populations are estimated by the respective entity, usually based on the number of service connections. In some cases, service area populations reported to the TWDB do not accurately reflect actual populations. To account for the difference in population estimates, the TWDB has historically estimated outside city municipal sales and adjusted total water use accordingly. While this provides a better estimate of the city per capita water use, it assigns all water losses to in-city use. If there are substantial outside city retail sales, this can overestimate in-city gpcd. The city of Austin has considerable outside city sales. Therefore, the service area population is used in this study to calculate the net municipal gpcd. For Temple, the service populations provided by the city were adjusted to better reflect the reported number of connections and census data. The use of service area population will result in different estimates of gpcd than the values reported by the TWDB.

Unaccounted-for Water
Unaccounted for water is the amount of water that the city cannot document through metering or sales. It typically includes leakage, spills or releases from broken pipes or other infrastructure, metering errors, and illegal connections. Depending on the accounting procedures of the city, it may also include fire water, water used for line flushing and other operational procedures that are not metered. It is often expressed as a percentage of the total amount of water pumped. Historically, the TCEQ has considered unaccounted for water of less than 15% as acceptable levels for retail distribution systems. Recent legislation (HB 3338) will require municipalities to perform water audits every five years to help reduce unaccounted for water losses. This legislation is expected to take effect beginning in 2006.

For this study, unaccounted-for water is the amount reported to the TCEQ and TWDB on the city's annual water use form. Typically, these quantities do not equal raw water pumped minus metered sales.

City of Temple Water Conservation Program

The city of Temple is located in northeastern Bell County approximately 36 miles south of Waco and 67 miles north of Austin. The city was founded in 1880 as a major junction of the Gulf, Colorado, and Santa Fe Railway by the railroad's chief engineer, Bernard Moore Temple.

The city of Temple receives its water from the Leon River and Lake Belton, which is a 12,300-acre reservoir on the Leon River. Temple has contracts with Brazos River Authority for approximately 22 percent of the water in Lake Belton. Based on the 2001 regional water plan, the city's allocation is projected to meet its expected water needs until at least 2050.

Since the city's current water supply is expected to meet its needs for at least the next 45 years, water conservation in Temple is focused on decreasing lost revenue from unaccounted-for water loss and increasing public awareness of conservation efforts during times of peak use.

Temple's Water Conservation Plan

The city prepared and adopted the City of Temple Drought Contingency and Water Conservation Plan in March 2000. The plan was developed to meet the requirements of Title 30 of the Texas Administrative Code Chapter 288 (30 TAC §288). The plan identifies three goals of the city's conservation program, including:

1. Encourage water conservation through public education. Conservation topics are addressed in mail outs and by the media during peak water use times.
2. Reduce unaccounted-for water loss.
3. Reduce water use (measured in gallons per capita per day) by five to ten percent by 2010.

The goals of the conservation program were developed with the understanding that in order for conservation efforts to be effective, the customers must respond to the public education materials, population growth must compensate for decreases in revenue from decreased water usage, and it must be feasible to reduce unaccounted-for water losses.

There are six major components to Temple's water conservation plan that were either already in place or developed to meet the city's conservation goals. These six components include metering, adoption of a plumbing code that requires water conserving plumbing fixtures, water rates, distribution system leak detection and repair, accounting, and recycling and reuse.

Metering. Temple currently has 21,649 metered service connections that account for all of the city's water use. Raw water is pumped from the Leon River and metered at each of the water treatment plant clarifiers. Residential meters are checked every ten years, and industrial and large commercial meters are calibrated annually.

Plumbing Code. Temple has adopted the Southern Standard Plumbing Code in the city's Code of Ordinances (Ordinance number 98-2583).

Water Rates. Temple has adopted a two-step block rate structure for all metered water services. The rate structure was adopted in the city's Code of Ordinances (Resolution number 99-2300-R). Initial water connection fees are charged based on meter sizes and connection lengths. The city also supplies water to Troy, Morgan's Point Resort, and Little River/Academy. The rate structure for water connections outside the city limits is the same as the rate structure established in the Code of Ordinances for metered services within the city limits.

Distribution System Leak Detection and Repair. Temple's Water Distribution Department is responsible for leak detection and repair. All city employees, customers, police officers, and meter readers take an active role in leak detection.

Accounting. Temple tracks monthly water sales and uses by residential, commercial/industrial, governmental/industrial, fire hydrants, or wholesale customers. Annual water loss is calculated to audit the amount of water pumped into the system and amount of water distributed through metered sales.

Recycling and Reuse. The city has recently implemented a reuse program for landscape irrigation at the Wilson Park ball fields. Approximately 3.795 million gallons of reuse water was used at the park in 2003.

Budgetary Commitment
According to the Water Conservation Plan, Temple's budget was developed to meet the operational and debt service costs of the water distribution system by allocating the revenue from water sales to the water utility budget. The current rate structure was established to meet budgetary and debt repayment needs plus a two and a half month reserve for contingencies.

Program Outlook
City of Temple Water Utility personnel are dedicated to providing a water distribution system that can meet the needs of an increased service population while also developing reuse efforts to minimize the demand on the existing distribution system at peak use times.

Effectiveness of the Water Conservation Plan/Program
In order to evaluate any potential impacts of the water conservation plan on water use and/or unaccounted-for water loss in Temple, water use and conservation data were collected from the city. The data included:

- Monthly water use data (starting in 1990);
- Annual unaccounted-for water loss data (starting in 1995);
- Annual service population data (starting in 1990);
- Annual per capita income data (starting in 1990); and
- Annual total of building permits issued (starting in 1990).

Data from the TWDB on population, water use and industrial and municipal sales from 1980 to 2001 were used to supplement data received from the city and provide a longer history of water use.

The effectiveness or impacts of the water conservation plan was estimated based on water use and changes in unaccounted-for water loss after the implementation of the plan. The relationship of water use to economic development and the service population was also evaluated.

Climatic data were collected for the time period under evaluation to determine if changes in climatic parameters such as average monthly temperature or annual rainfall influenced the changes in water use. Annual rainfall from 1990 to 2003 ranged from 20.3 inches to 47.3 inches per year. Monthly precipitation had greater variability, ranging from 0 inches to 13.5 inches. The average annual temperature over the period of record ranged from 65.3 to 69.0 degrees Fahrenheit, with an average low temperature of 48° F in January and high of 86° F in July. Comparisons of total monthly water use to monthly precipitation and average monthly temperature are shown on Figures 1 and 2 respectively. Comparisons to summer climatic conditions are shown on Figure 3.

Evaluations of the monthly water use data found a notable seasonality of the data, which appears to be primarily associated with rainfall. Years with lower total annual rainfall appear to have a higher average non-summer monthly use, but peak month usage was more directly related to summer precipitation (or lack of precipitation). Comparisons of total water use to annual rainfall did not directly correlate. For example, in year 2000, the total annual rainfall was 44.9 inches (approximately 8.8 inches above the average over the study period). However, the total municipal water used in 2000 was the highest during this same time. One reason is the very high usage in the summer months (most likely due to outside watering) when there was little to no rainfall. Higher rainfall in winter months had little impact on winter water usage. Therefore, it appears that total water usage is a function of monthly precipitation in the summer and less so in the winter months. While temperature varied with the seasons, the average temperatures did not vary significantly from year to year and had little impact on total water use.

Per capita income and building permit data was obtained to compare trends in water consumption to economic development in the Temple area. Per capita income data was obtained for the city of Temple from the U.S. Department of Commerce Bureau of Economic Analysis for 1990 to 2001. Per capita income in the Temple area was approximately $23,415 in 2001. However, since income data was unavailable for 2002 and 2003, income was not used to evaluate the trends in economic development since the water conservation plan was adopted in 2000.

Building permit data was collected from the city's Planning Department as a second indicator of economic development. As shown on Figure 4, there appears to be an increase in economic development in the mid to late 1990s, with an increase in activity again during the last three years (2001 to 2003). The number of building permits issued reached a peak in 1996, which corresponds to a peak in water use. However, the increased water use may be more related to the drought of 1996 than to building activities. The recent rise in building activities, beginning in 2001 does not correlate to an increase in municipal water use.

Service area population for the city of Temple has increased at a fairly steady rate since 1992, and municipal water use has generally trended upward with service population (see Figure 5). Overall, per capita water use in Temple has decreased since the implementation of the water conservation plan in March 2000, but the time period is too short to assess whether this reduction is associated with the conservation plan or is simply within normal variations. As shown on Figure 6, the average per capita water use prior to year 2000 is 208 gpcd. The average per capita use between 2000 and 2003 is estimated at 191 gpcd, which represents a reduction of 17 gpcd. Much of this reduction appears to be related to improved metering and reduced unaccounted-for water. Unaccounted-for water losses are shown on Figure 7 and range from 15.5% to 27.5 % for years prior to the implementation of the water conservation plan. The city reports significant reductions in unaccounted-for water in years 2002 and 2003, which is attributed to a concerted effort to reduce

Figure 1A
Total Water Usage and Monthly Rainfall
City of Temple, 1990-2003

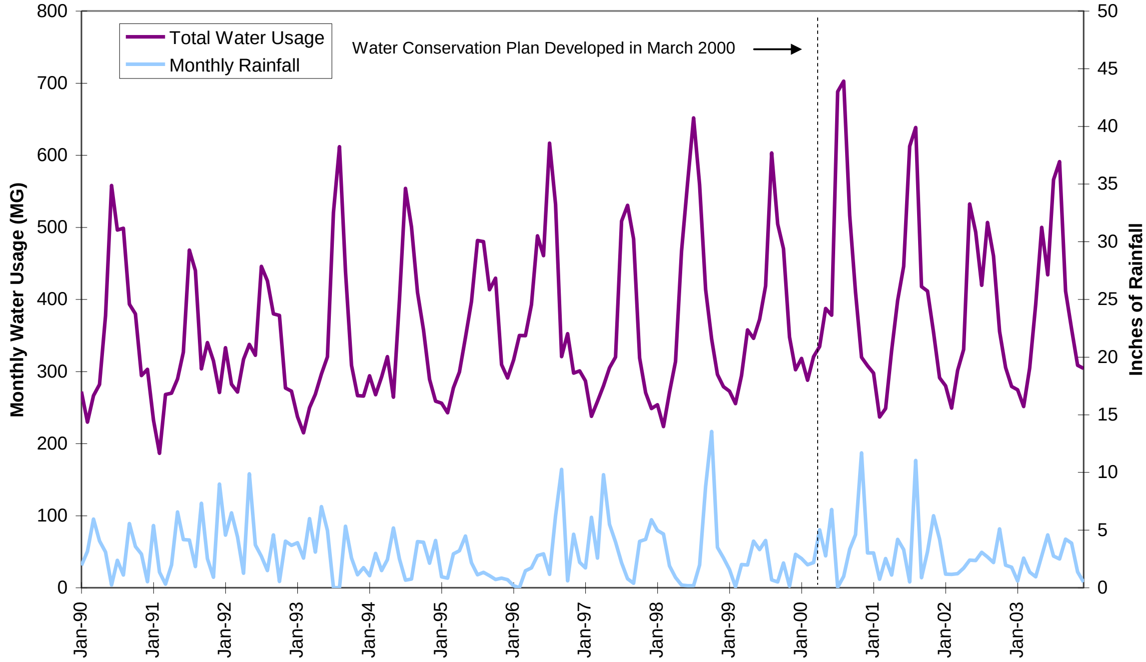


Figure 1B
Monthly Water Use vs. Rainfall
City of Temple, 1990 - 2003

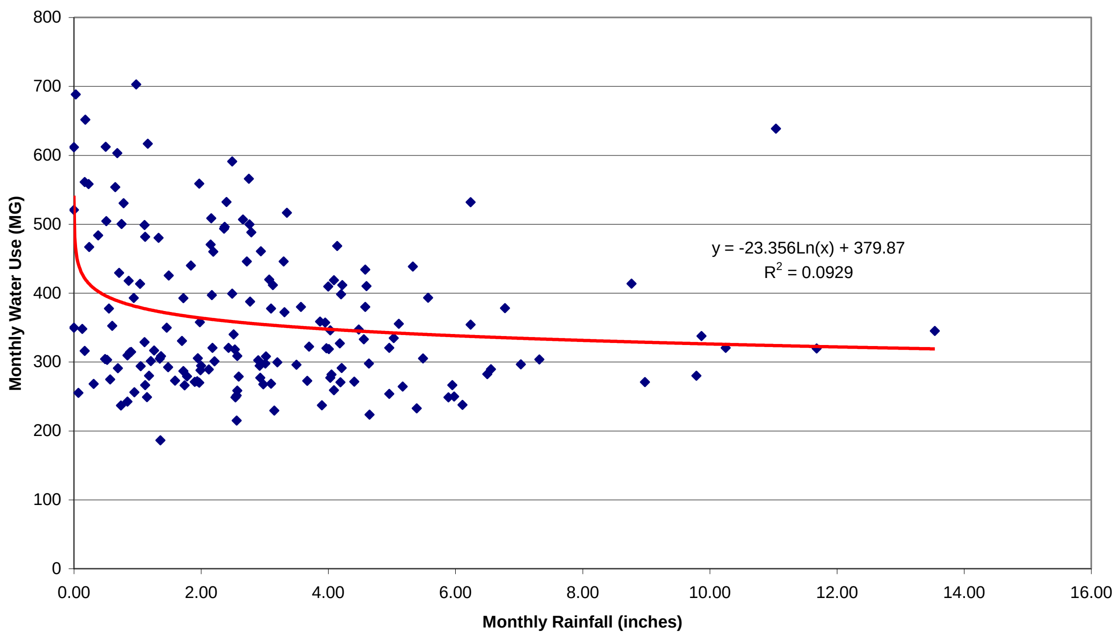


Figure 2A
Total Water Usage and Average Monthly Temperature
City of Temple, 1990-2003

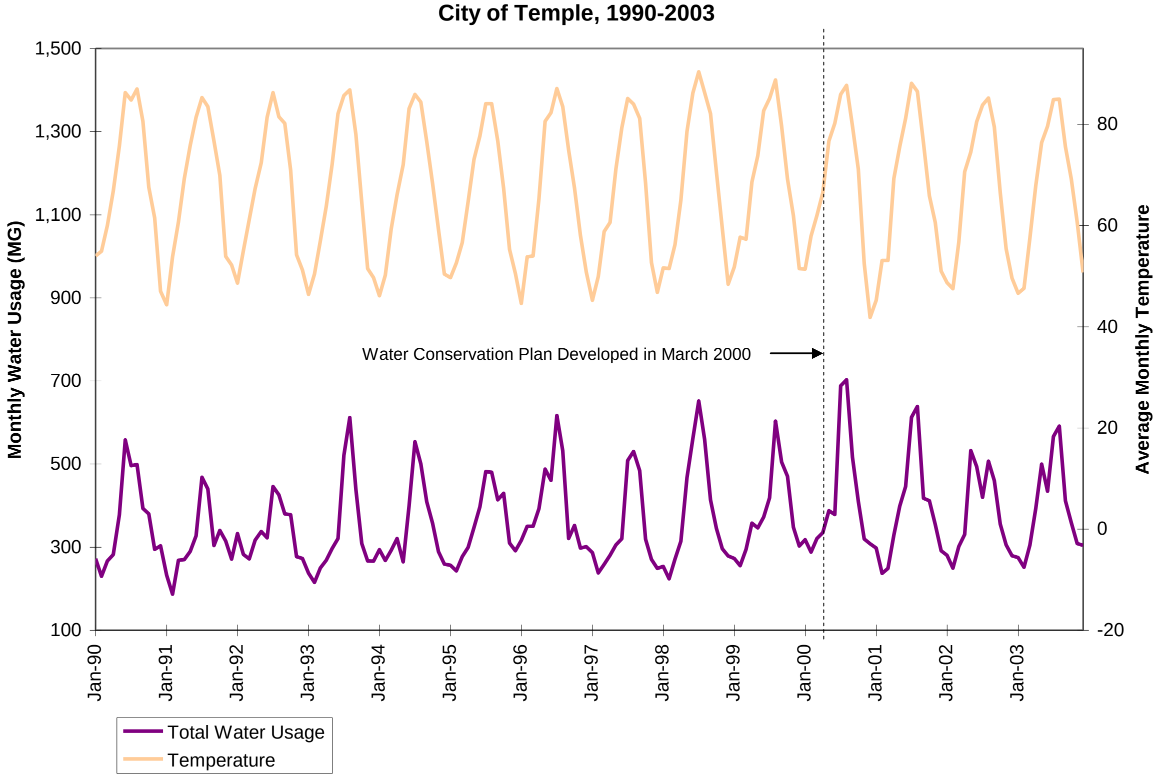


Figure 2B
Monthly Water Use vs. Average Temperature
City of Temple, 1990 - 2003

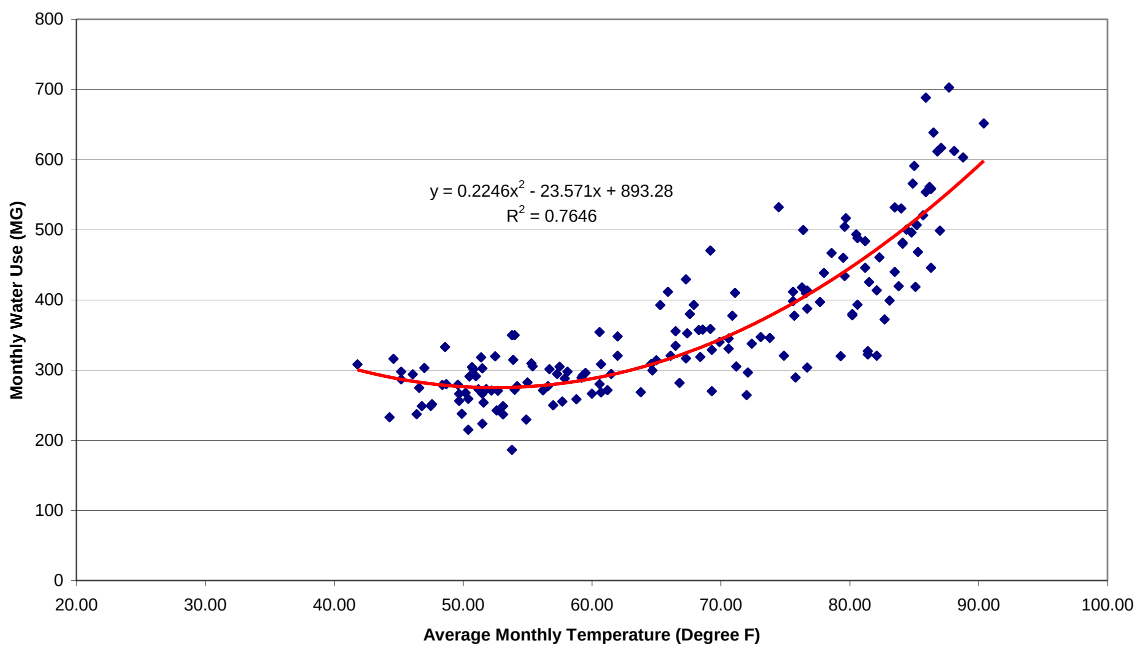


Figure 3
Municipal Water Usage and Summer Climatic Data
City of Temple, 1990-2003

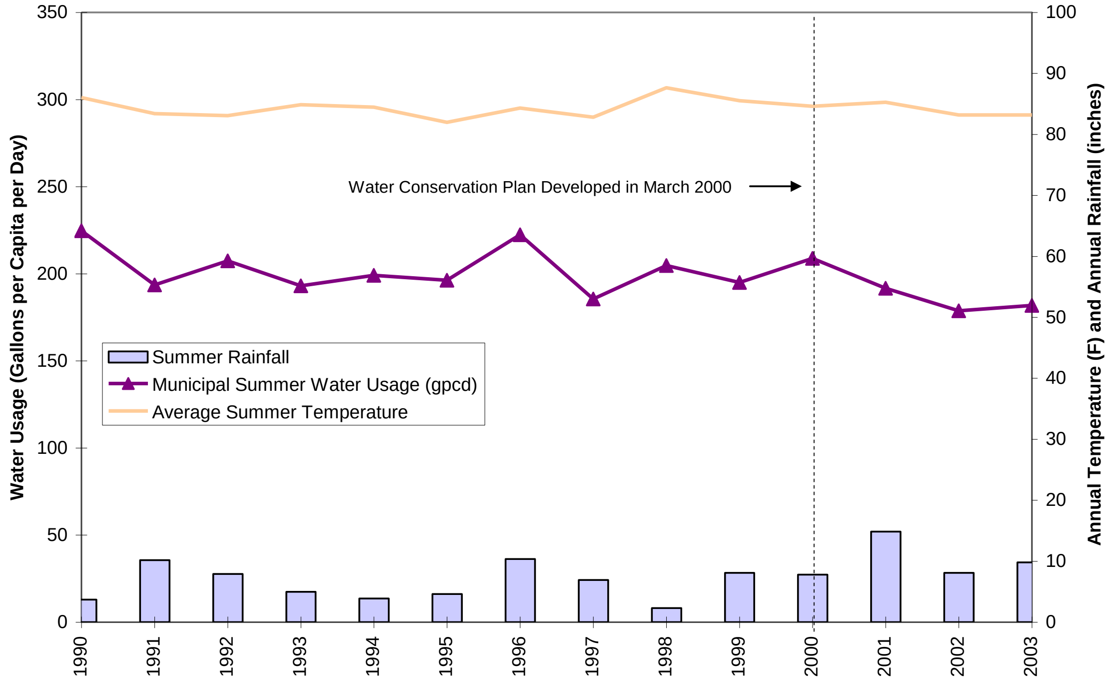
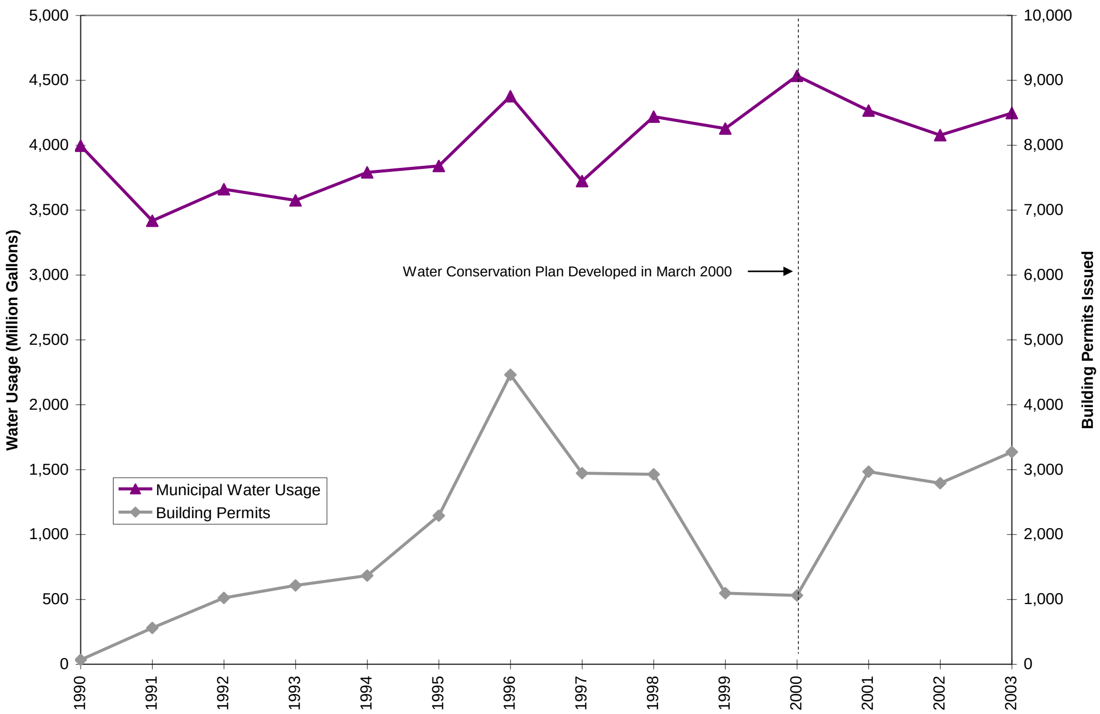


Figure 4
Municipal Water Usage and Economic Development
City of Temple, 1990-2003



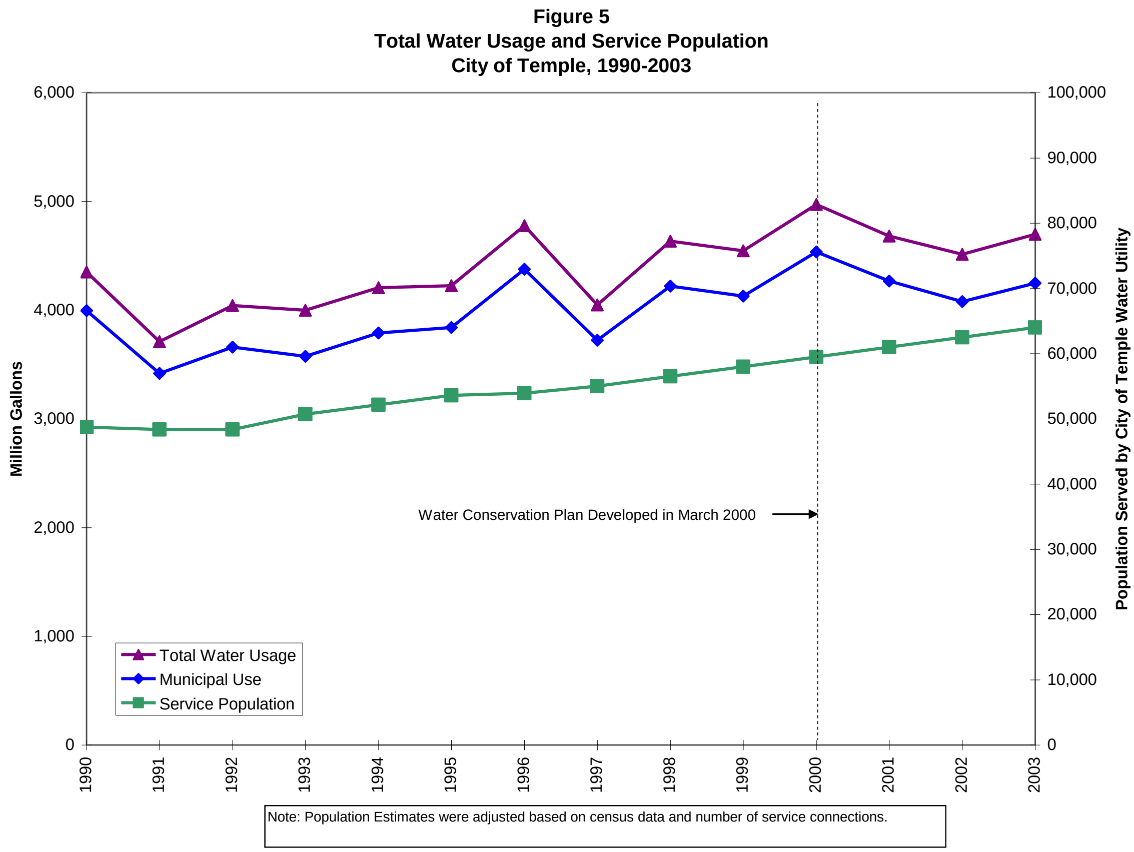


Figure 5
Total Water Usage and Service Population
City of Temple, 1990-2003
Million Gallons
Population Served by City of Temple Water Utility
Water Conservation Plan Developed in March 2000
Total Water Usage
Municipal Use
Service Population
Note: Population Estimates were adjusted based on census data and number of service connections.

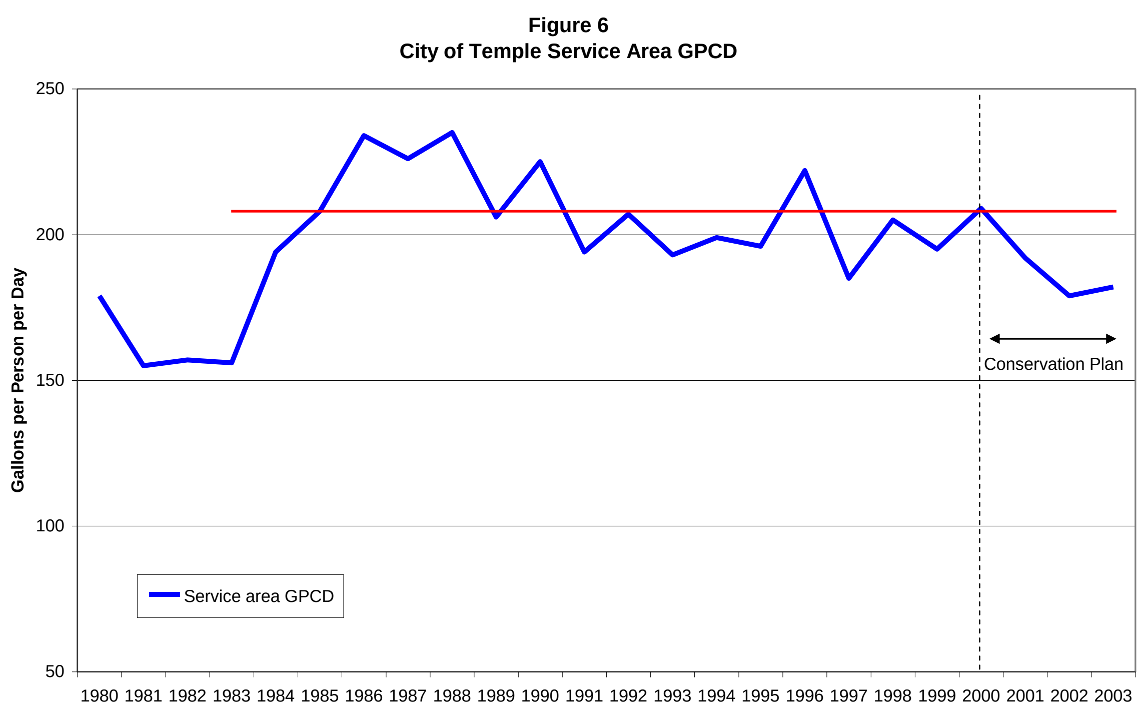
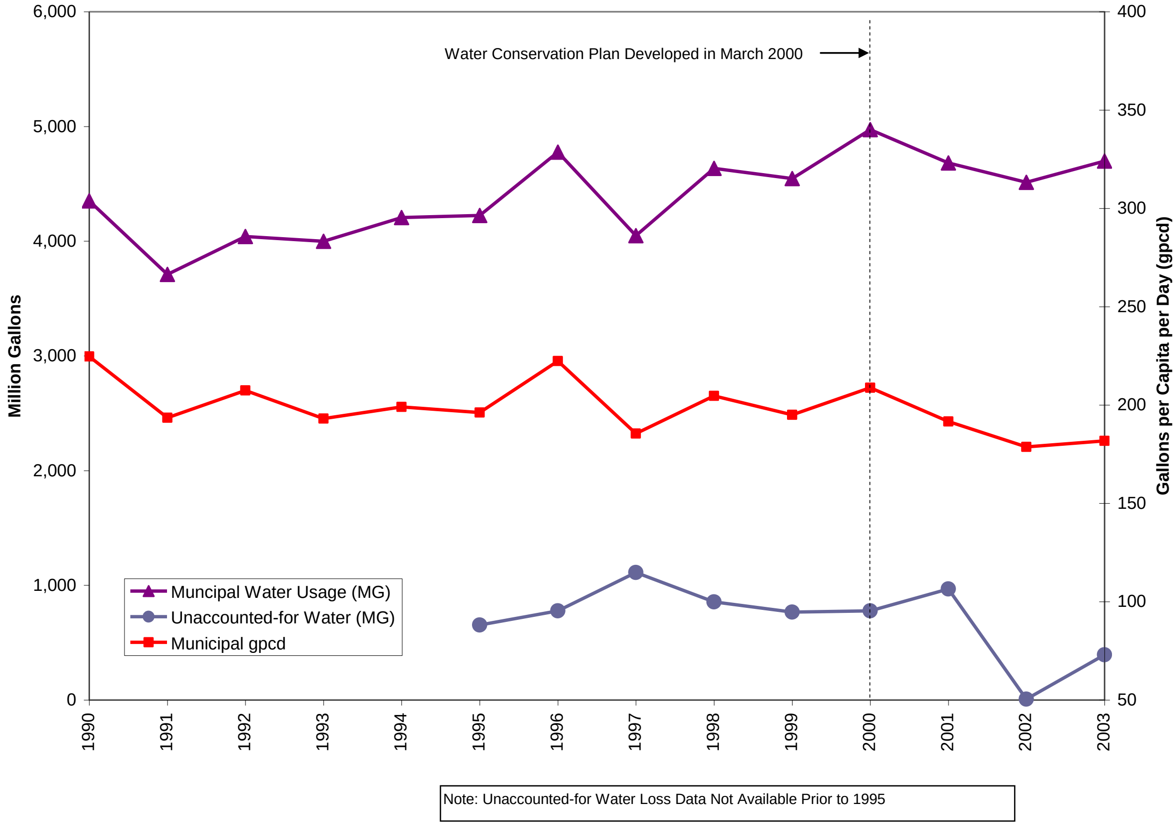


Figure 6
City of Temple Service Area GPCD
Gallons per Person per Day
Conservation Plan
Service area GPCD

Figure 7
Municipal Water Usage and Unaccounted-For Water
City of Temple, 1990-2003



losses and the construction and development of a new water treatment plant and distribution system expansion. However, the unaccounted-for water loss reported for year 2002 (less than 0.02%) appears to be in error. Comparisons of total pumpage with sales in 2002 indicate loss rates similar to those in previous years.

Based on the straight comparisons of water use and unaccounted-for water, the implementation of the water conservation plan in Temple appears to have been effective in reducing overall annual water use and unaccounted-for water. Per capita water use has decreased approximately 8 percent (17 gpcd) since the water conservation plan was adopted in March 2000. Unaccounted-for water loss in 2003 was reduced from an average loss rate of 18.4 % to 8.4%, which corresponds to a reduction of approximately 18 gpcd. This indicates that nearly all of the reductions appear to be attributed to reductions in unaccounted-for water. However, it is uncertain whether the unaccounted for water reduction is truly due to reducing water losses or better calibrated meters and accounting of water uses. The lower water use could also be attributed partly to higher summer rainfall. The amount of data after the implementation of the water conservation plan is insufficient to attribute these observed reduced water uses solely to the city's conservation efforts.

CITY OF AUSTIN WATER CONSERVATION PROGRAM

The city of Austin is located in central Travis County and receives its water from the Colorado River and Highland Lakes system. The 2001 Region K Water Plan reported a firm available supply to the city of 371,856 acre-feet per year (including steam electric and 325,000 acre-feet per year for municipal use). These supplies are expected to meet the city's demands through 2030 under drought of record conditions.

In 1982, Austin's water use neared its high water pumpage capacity during the summer months. In response, the city developed an Emergency Water Conservation Ordinance, which initiated the city's water conservation efforts. The water conservation program since that time has expanded to not only focus on emergency needs but also long-term conservation efforts to reduce average day and peak day demands.

Austin's Water Conservation Plan

The city of Austin developed its water conservation program in 1985 as a joint venture of the Planning, Environmental, and Conservation Services Department and the Water and Wastewater Utility. From 1985 to 1987, the city initiated an aggressive door to door program to install water efficient showerheads and faucet aerators. Other activities were identified and incorporated into the program over the years, and the city adopted its first water conservation plan in 1993. The plan was updated in 1999 to meet the requirements of 30 TAC §288.

The 1999 Water Conservation Plan identifies three goals of the city's conservation program, including:

1. Reduce the 1990 projection of year 2005 peak day water use by ten percent.
2. Reduce average per capita daily water use by five percent.
3. Reduce projected year 2050 demand by 25,000 to 50,000 acre-feet per year (approximately 7 to 14%).

Austin's water conservation plan outlines system-wide conservation efforts in the following categories:

- Single-family, Indoor programs
- Single-family, Outdoor programs
- Xeriscaping
- Multi-family, Indoor programs
- Multi-family, Outdoor programs
- Industrial/Commercial/Institutional, Indoor programs
- Industrial/Commercial/Institutional, Outdoor programs
- Children's Education
- Public Education
- Utility Management
- Water Reuse and Recycling

Single-family, Indoor programs. The city offers several incentive programs for residential properties including rebates for low-flush toilets, water efficient clothes washers, and low-flow showerheads.

The city also distributes leak detection kits to residential customers at information fairs and by request.

Single-family, Outdoor programs. The water conservation program also includes incentives and rebates for single-family residential properties that plant water efficient shrubs and trees or install a rainwater harvesting system. In addition, the city offers free irrigation system audits for customers with monthly usage (in the summer months) exceeding 15,000 gallons. Rebates are offered to residents who choose to upgrade existing irrigation systems with new systems that have water conservation features.

Xeriscaping. The city of Austin and Xeriscape Garden Club have a demonstration garden that provides water utility customers with information about water conserving landscaping. The city also offers awards to local landowners who have utilized water-wise landscaping in their yards. A tour of homes and one-day workshop on xeriscaping are also promoted by the city and Xeriscape Garden Club.

Multi-family, Indoor programs. Similar to the programs offered to single-family residential customers, owners and managers of multi-family complexes can also receive incentives from the city for the use of low-flush toilets in each unit. Multi-family complexes are also eligible for rebates from installing water efficient clothes washers in community laundry facilities.

Multi-family, Outdoor programs. All multi-family properties are eligible for a free irrigation system audit and rebates for upgrades to an existing irrigation system. Owners and managers can also receive rebates for the installation of a rainwater harvesting system.

Industrial/Commercial/Institutional, Indoor programs. Commercial and industrial properties can receive rebates and grants for installing equipment or redesigning processes that are more water efficient, such as reusing high quality rinse water or replacing single-pass cooling with recirculating cooling systems. Incentives are available for using low-flush toilets, waterless urinals, and low-flow showerheads. Facilities with community laundry facilities, coin-operated clothes washers, or industrial laundry equipment can receive rebates for installing water efficient equipment.

Industrial/Commercial/Institutional, Outdoor programs. Industrial and commercial facilities are eligible for free irrigation system audits and rebates from irrigation system improvements and rainwater harvesting under the same programs as single-family and multi-family customers. Additionally, the city offers training courses for professional irrigators in the Austin area that focus on water efficient irrigation systems and Austin's water conservation program.

Children's Education. The city of Austin has an elementary school-aged education program, the Dowser Dan Show, that teaches kids the importance of water conservation and how they can conserve water. The program reaches over 30,000 children each school year. The city also has a water-wise curriculum that provides hands-on experiments for fifth grade students to learn more about water conservation.

Public Education. Water conservation materials are provided to customers through bill stuffers and media campaigns. One media campaign, Peak Day Management, focuses on water conservation efforts during the summer months to reduce outdoor water use. A water conservation program website is also available and includes tips on minimizing water use and information about the city's various incentive programs.

Utility Management. The city's water rate structure was developed as an inverted block rate structure to provide single-family residential customers with conservation incentives. The city also has a leak detection program and extensive and comprehensive metering system and maintains records of water distribution, sales, and water accounting, including calculating unaccounted-for water uses.

Water Reuse and Recycling. Austin's Water Reclamation Initiative (WRI) Program is currently supplying water for non-potable water uses including golf course irrigation and uses at the wastewater treatment plants. The reclaimed water systems are being expanded to extend service to additional customers including in the Robert Mueller Municipal Airport (RMMA) redevelop site area and to industrial sites. The City of Austin has conducted master planning for its reclaimed water systems and continues to evaluate and plan for expansions. Reuse is a key component of Austin's long-range water supply and conservation plans.

Budgetary Commitment

The current water conservation program as outlined in the 1999 Water Conservation Plan is incorporated into the city budget for funding through 2005. In 1999, the city was evaluating additional funding through municipal bonds and/or TWDB sources to develop, design, and construct a reuse system and facilities. Austin continues to plan and schedule its Water Reclamation Initiative (WRI) reclaimed water system expansion projects through its annual Capital Improvements Program funding process. Austin is currently conducting a Bureau of Reclamation Title XVI Study in pursuit of securing additional funding through a federal grant funding program.

Program Outlook

City of Austin Planning, Environmental, and Conservation Services Department and Water and Wastewater Utility personnel support the water conservation program. The City estimates that the current water supply will meet the city's water demand through 2050 utilizing conservation and reuse to reduce demand by an estimated 50,000 acre-feet per year by 2050.

Effectiveness of the Water Conservation Plan

In order to evaluate any potential impacts of the water conservation program started in 1985 and the water conservation plans adopted in 1993 and 1999 on water use and/or unaccounted-for water loss, water use and conservation data was collected from the city. The data included:

- Monthly water use data (starting in 1980);
- Annual unaccounted-for water loss data (starting in 1993);
- Annual service population data (starting in 1980); and
- Annual total of building permits issued (starting in 1998).

The effectiveness or impacts of the water conservation plan was estimated based on water use after the implementation of the water conservation program in 1985. The relationship of water use to economic development and the service population was also evaluated.

Total water use for the city of Austin has increased from 28 billion gallons in 1980 to 51 billion gallons in 2003 (see Figure 8). Of these amounts, approximately 6 to 16 percent is associated with wholesale and industrial sales. Most of the water usage is for municipal use within the city's service area. As such, the increase in water usage trends upward with increased service area population, yet per capita water use has decreased approximately 20 gpcd since the initial conservation efforts in 1985. Figure 9 presents the historical municipal gpcd for Austin from 1980 to 2003. As shown on this figure, there appears to be two distinct levels of per capita water use, one prior to 1990 and one after 1990. Prior to conservation efforts in 1985, the per capita water use was 176 gpcd. From 1991 to 2003, the average usage was approximately 156 gpcd. Per capita water use over the last decade has remained fairly constant with some slight fluctuations due to climatic conditions.

As with the city of Temple, comparisons of climatic data to water usage for the city of Austin also found seasonal fluctuations that appear to be related to monthly precipitation. Annual precipitation for Austin is similar to Temple with an average rainfall of 34 inches per year. The difference is that the annual water use for Austin seems to better correlate with the total annual precipitation than for the city of Temple. Slight peaks and dips in annual water use correspond to dry and wet years. The seasonal summer peaks for Austin are approximately 1.6 times the average winter use[2], whereas for the city of Temple, the average summer peaking factor was approximately 1.8. This indicates that a slightly higher impact will be seen in Temple's water use during dry summer months. As with Temple, average annual temperature does not appear to have a significant impact on water usage. The seasonal variations observed with temperature are more likely associated with the seasonal variations of precipitation and outdoor watering. The average annual temperature over the period of record ranged from 66.2 to 71.2 degrees Fahrenheit. (Figures 10 through 12 show monthly and climatic data for Austin.)

Two different data sets were obtained to compare trends in water consumption to economic development in the Austin area, building permits and per capita income. Building permit data were collected from the Planning Department's online database as one indicator of economic development. However, the database only contained data from 1998 to 2003. Sufficient building permit data were not available to be used as an indicator at the time of this study.

The second indicator of economic development used was per capita income. Per capita income data was obtained for the city of Austin from the U.S. Department of Commerce Bureau of Economic Analysis for 1980 to 2001. Per capita income in the Austin metropolitan area has increased from $15,001 in 1985 to $31,511 in 2001, representing a 110 percent increase. As shown in Figure 13, there appears to be a trend upward in average per capita income beginning in 1997. This is most likely associated with the rise of the high-tech industry in the Austin area. Despite increased economic development in the area and higher incomes, the average per capita water use has remained fairly constant.

[2] Winter use is defined as the average use between November and March (inclusive). Summer use is the average use for the three highest summer months (July – September).

Figure 8.
Total Water Usage, Municipal Water Usage and Service Population
City of Austin, 1980-2003

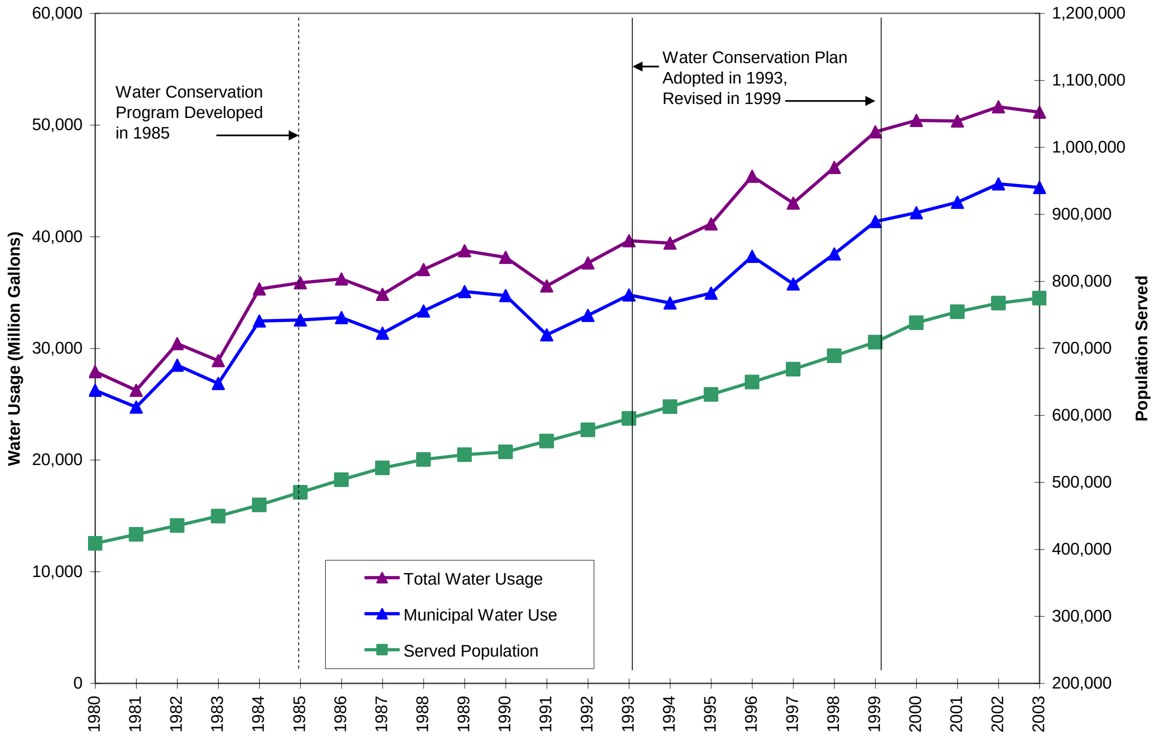


Figure 9
City of Austin Service Area Historical Municipal GPCD

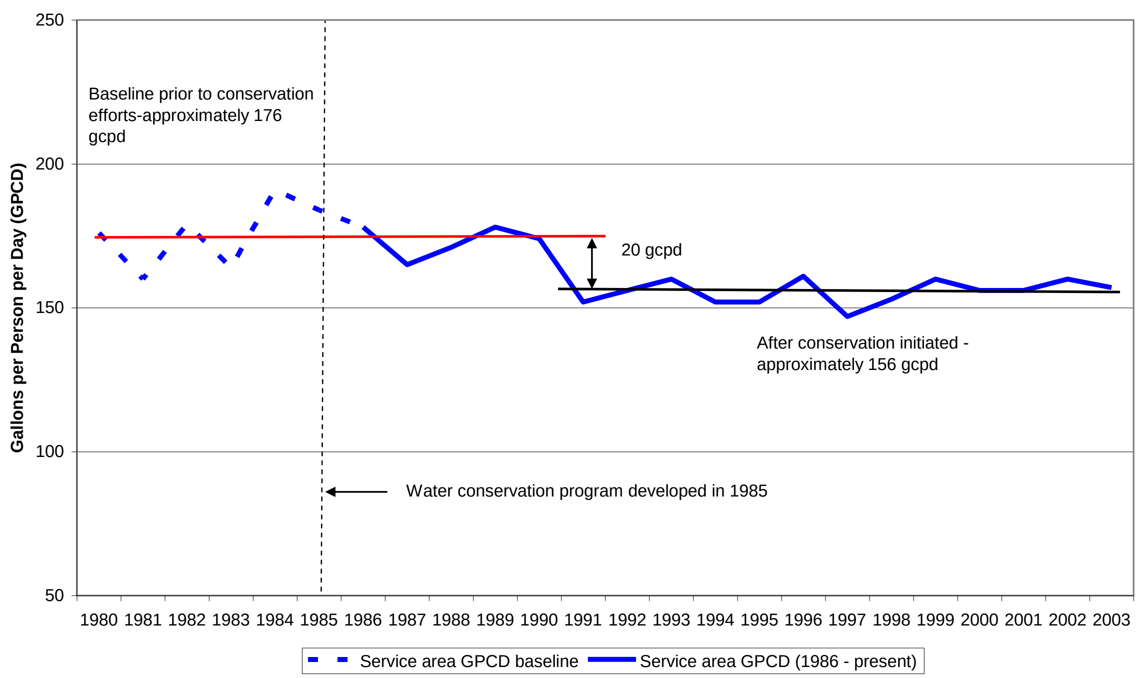


Figure 10A
Total Monthly Water Usage and Monthly Rainfall
City of Austin, 1980-2003

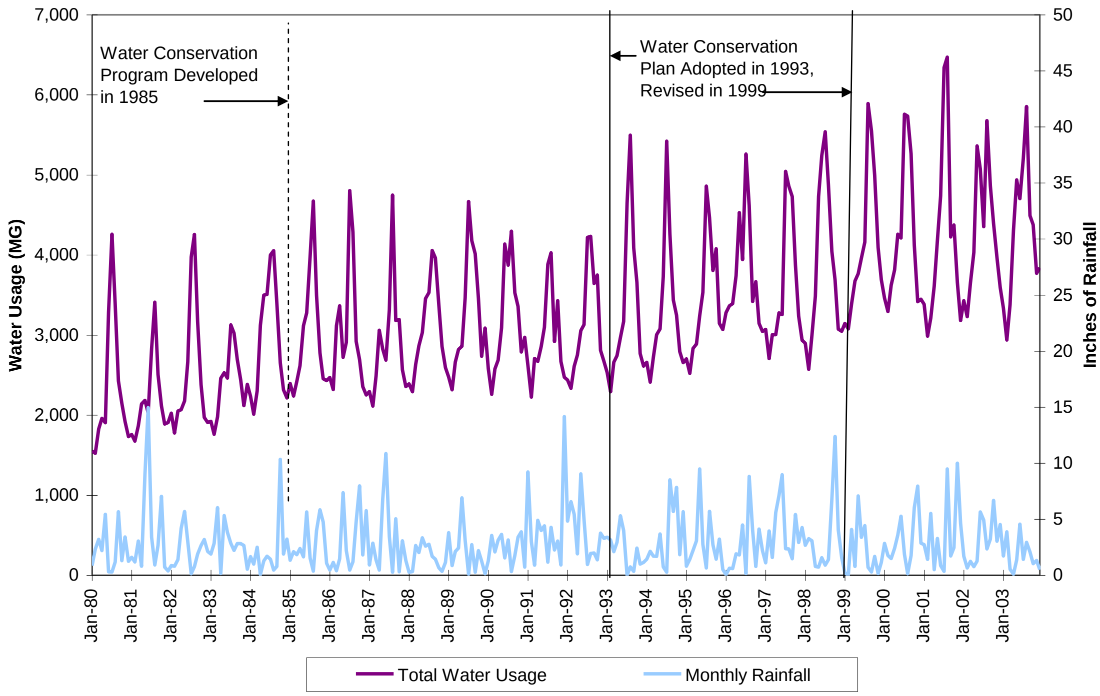


Figure 10B
Monthly Water Use vs Rainfall
City of Austin, 1980 - 2003

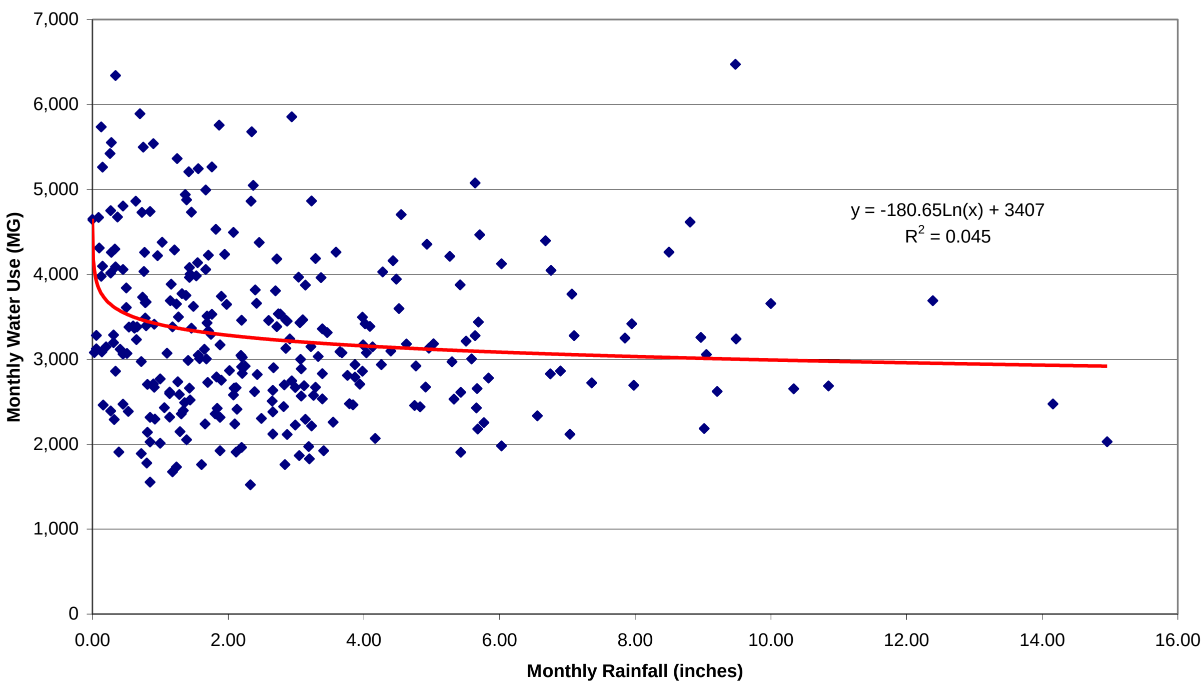


Figure 11A
Total Monthly Water Usage and Average Monthly Temperature
City of Austin, 1980-2003

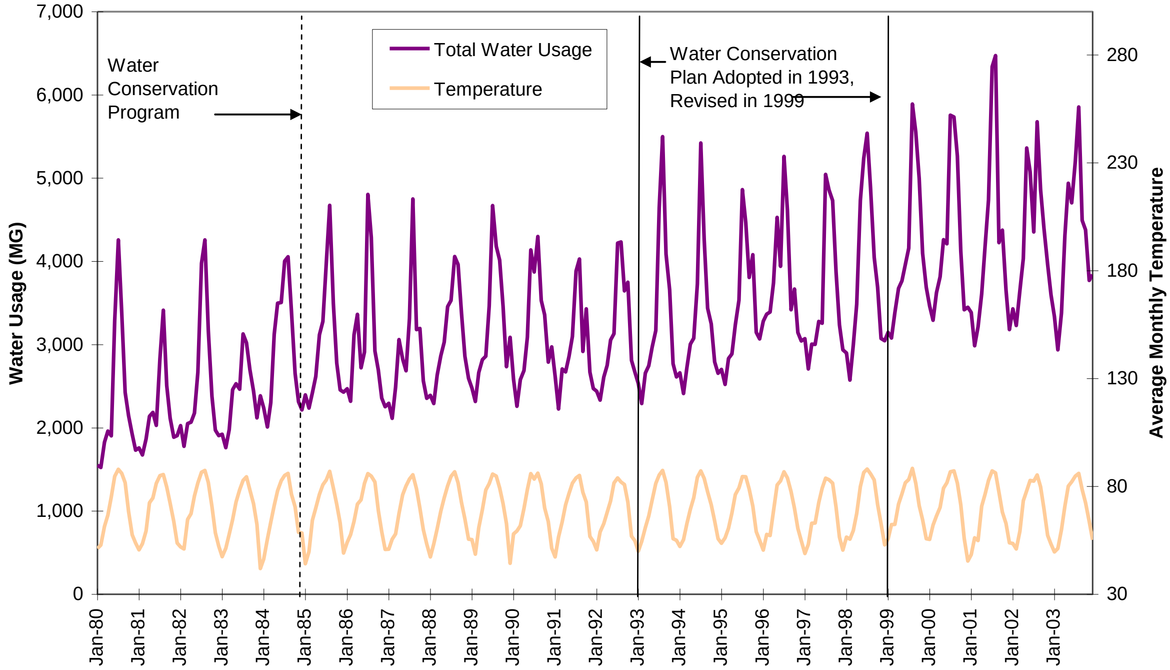


Figure 11B
Monthly Water Use vs Average Temperature
City of Austin, 1980 - 2003

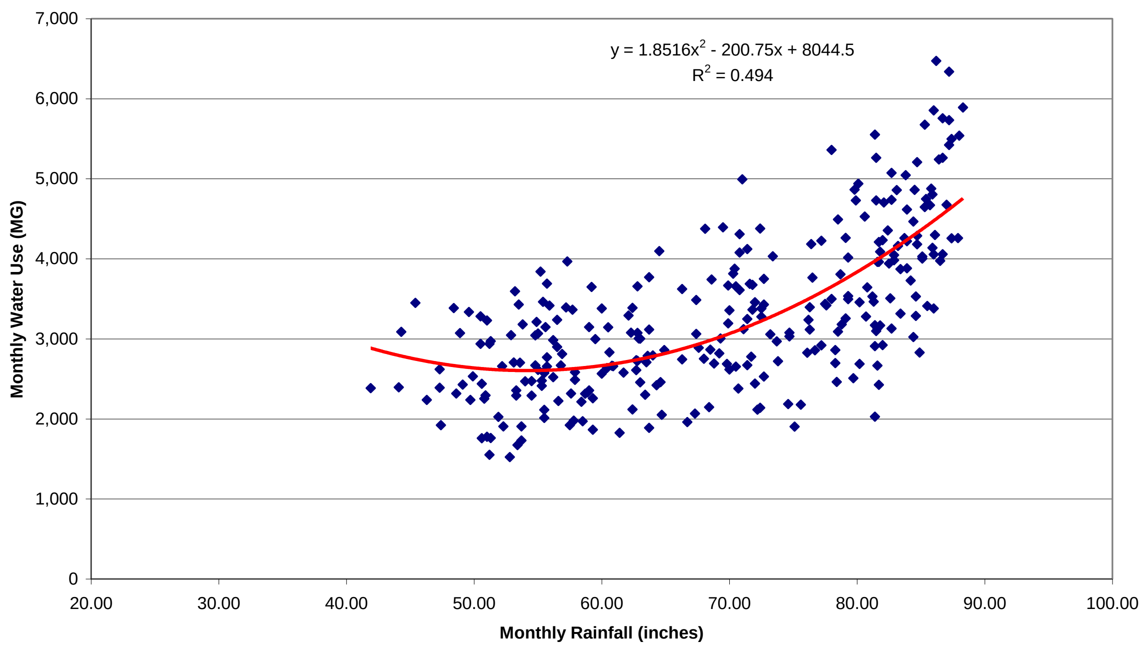


Figure 12
Municipal Water Usage, Average Summer Climatic Data
City of Austin, 1980-2003

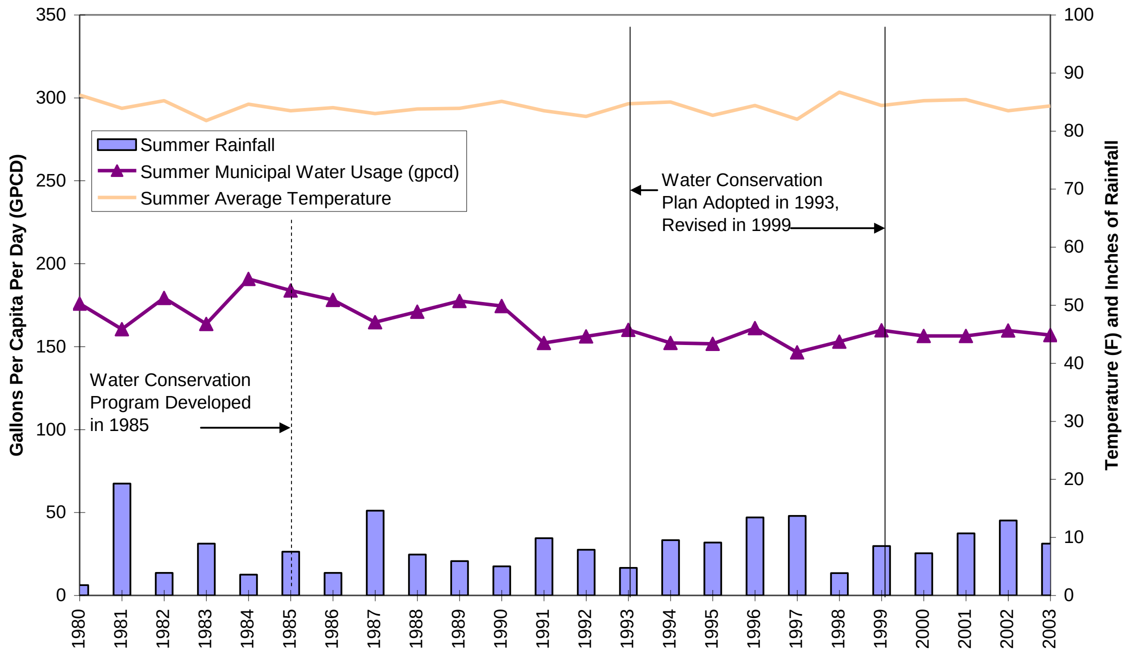
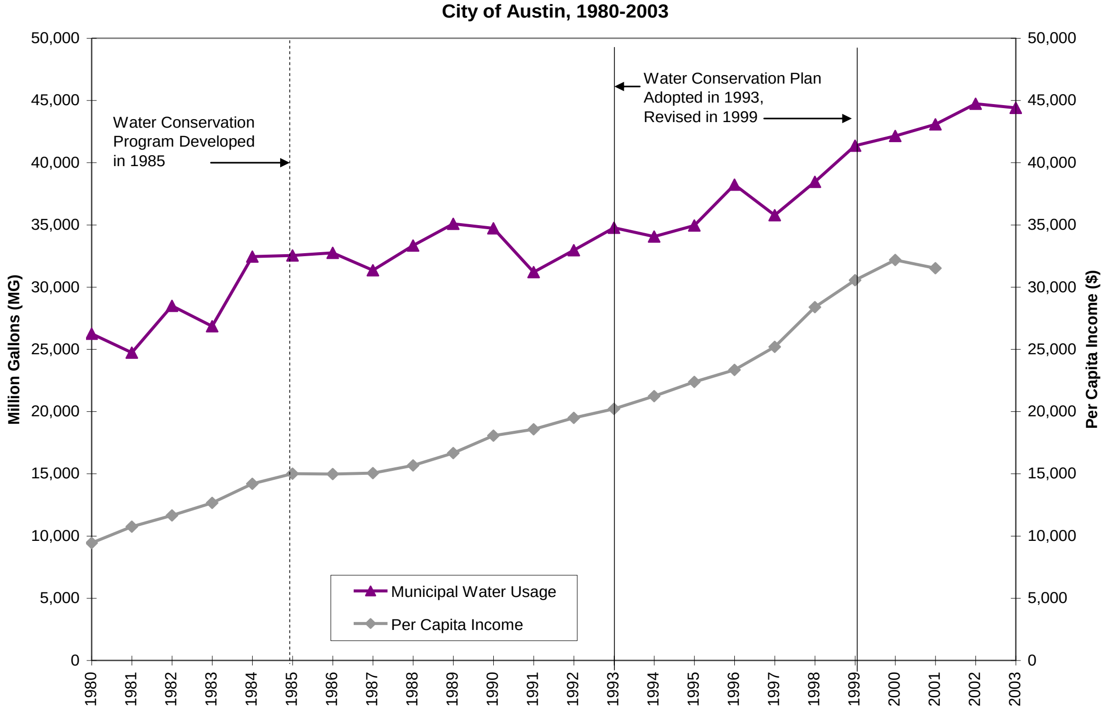
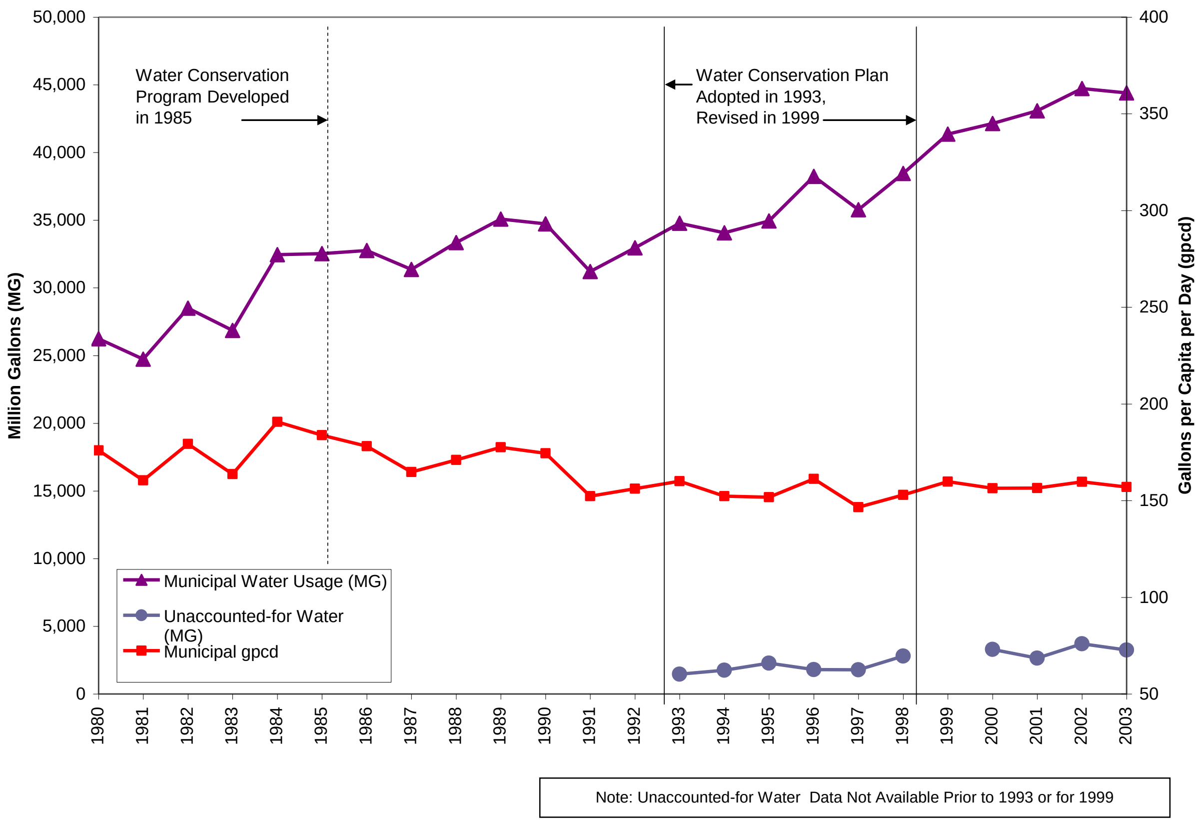


Figure 13
Municipal Water Usage and Economic Development
City of Austin, 1980-2003



Another measure of the effectiveness of a water conservation program may be a reduction in unaccounted-for water. Data for unaccounted-for water was available from 1993 to 2003, with the exception of 1999 where information was not available for August or September. Unaccounted-for water remained fairly constant during that time, as shown in Figure 14, ranging from 4 to 7 percent of the total system pumpage, which is well below the conservation program's goal to keep unaccounted-for water uses lower than 15 percent. A significant reduction in unaccounted-for water use may have occurred prior to 1993 after the initiation of the program in 1985, but data are not available to quantify these savings.

Figure 14
Municipal Water Usage and Unaccounted-for Water
City of Austin, 1980-2003



Based on the straight comparisons of water use, the implementation of the water conservation program in Austin has been effective in reducing overall annual water use and maintaining unaccounted-for water well below typical levels. Average per capita water use has decreased approximately 11.4 percent (20 gpcd) since the water conservation program started in 1985. This decrease is likely attributed to the multitude of conservation programs the city has put in place as well as reductions in unaccounted for water. Estimates of water savings for different types of conservation measures are shown in Table 1.

Accounting for all of Austin's conservation strategies that are currently in place, there is the potential to reduce per capita water use by about 14 gpcd if the target adoption rate is met. Additional per capita reductions due to commercial efficiency strategies are small (approximately 1 gpcd).

Reductions seen to date are approximately 20 gpcd from pre-conservation plan use, and actually may be greater if compared to expected use without conservation. Some of this reduction may be associated with reduced unaccounted for water, but this cannot account for all of the reduction. Continued decline in per capita water use after 1991 is not evident in this study. However, the conservation plan may be keeping per capita use in check when it otherwise would have increased due to higher water uses associated with suburban development with higher income levels.

Table 1
Water Savings Associated with Different Water Strategies

Water Efficiency Strategy	**GPCD Savings**	**Employed by Austin**	**Potential Adoption Rate**	**Austin Savings[1] (GPCD)**
SF Toilet Retrofit	10.5	x	50%	5.25
SF Showerheads	5.5	x	50%	2.75
SF Clothes Washer Rebate	5.6	x	90%	5.04
SF Irrigation Audit	20.3	x	5%	1.02
SF Rainwater Harvesting	8.7	x	5%	0.44
SF Rain Barrels	0.9	x	30%	0.27
MF Toilet Retrofit	10.5	x	60%	6.30
MF Showerheads	5.5	x	60%	3.30
MF Clothes Washer Rebate	1.2	x	80%	0.96
MF Irrigation Audit	1.8	x	50%	0.90
MF Rainwater Harvesting	3.7	x	5%	0.19
POTENTIAL SAVINGS*				**13.72**

SF – single family unit MF- multi-family unit

1. Potential savings for Austin were calculated assuming twice the SF population as MF population

Commercial Water Efficiency Strategy	**Savings**	**Employed by Austin**	**Assumed Number of Measures**	**Austin Savings (GPD)**
Commercial Toilet Retrofit	26 GPD	x	20,000	520,000
Coin-Operated Clothes Washer Rebate	24 gal/washer	x	300	7,200
Irrigation Audit	125 GPD	x	500	62,500
Commercial General Rebate	1 gal/rebate $	-		
Commercial Rainwater Harvesting	35.2 GPD	x	200	7,040

Source: *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas*, prepared for the Texas Water Development Board, GDS Associates, May 2003.

CONCLUSIONS DRAWN FROM CASE STUDIES

Both communities evaluated in the water conservation studies recognized a reduction in overall water usage and unaccounted-for water following the adoption of their respective water conservation programs. For Temple it is unknown whether these reductions are associated with the water conservation plan or other factors. For Austin, the data following the implementation of the conservation plans extend over a varied climatic period for more than ten years, which indicate that the observed reductions are related to the implementation of water conservation strategies. Based on limited data it appears that some of the observed reductions in per capita water use are associated with reductions in unaccounted-for water. In fact all or nearly all of Temple's reduction in per capita use appears to be directly due to lower unaccounted-for water, which may or may not be reflective of actual reductions in water losses but rather better accounting methods. Austin's per capita water use has decreased more than what could be attributed to reduced unaccounted-for water. Reductions due to other measures appear to be occurring, but quantified reductions for each conservation strategy could not be assessed.

While both case studies indicate reductions in water use, the differences in each program's life-span and strategies make it difficult to compare the two cities directly.

In Austin, the water conservation program includes several incentive and rebate programs that are not used in Temple, including low-flush toilets, low-flow showerheads, and rainwater harvesting. In addition, the Austin water conservation program was initiated in 1985, nearly 15 years before Temple's water conservation plan was adopted. Austin's prominence as a rapidly growing metropolitan area directed most of its early proactive water conservation strategies.

In Temple, water conservation appears to have been effective, at least in the short-term, to better account for unaccounted-for water and convey conservation messages at peak use times of the year. Further data are needed to confirm that these observed reductions are due to the city's efforts in reducing water uses and losses, or other factors such as summer rainfall. Recent population growth has prompted the city to construct a new water treatment plant and expand its distribution system. This may be contributing to lower water losses associated with older leaking infrastructure. Further reductions are unlikely, and the city may actually see water losses increase as the new system ages.

In general, the results of this study indicate that additional focus on water conservation can be effective in reducing total water use and unaccounted-for water over the short-term. Specifically, efforts to reduce water losses are a pro-active strategy that can be undertaken by the city directly. The impacts of these efforts appear to be realized over a relatively short time period, but require continued efforts to maintain these reductions. Other proactive, incentive-based programs, such as Austin's, prove effective in providing a long-term reduction in water demand. However, the continued impacts of the plans are uncertain. Many of the conservation measures available to municipalities involve customer participation and in some cases, lifestyle changes. These changes often take time and require continual effort to maintain the effectiveness. Due to the short length of time since the Temple water conservation plan was adopted, it remains unclear if limited water conservation strategies like Temple's will provide a sustained reduction in water demand. For Austin, continued reductions in per capita water use may be occurring, but are not readily discernable from the data. Changes in economic characteristics in Austin, including a general increase in affluence and an increase in the installation of automatic irrigation systems, may mask the reductions in water use from other conservation measures. Further study is needed to assess estimated per capita water use that would occur if no conservation strategies were in place.